Predictive Microbiology: an overview and a practical application

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Predictive Microbiology: an overview and a practical application

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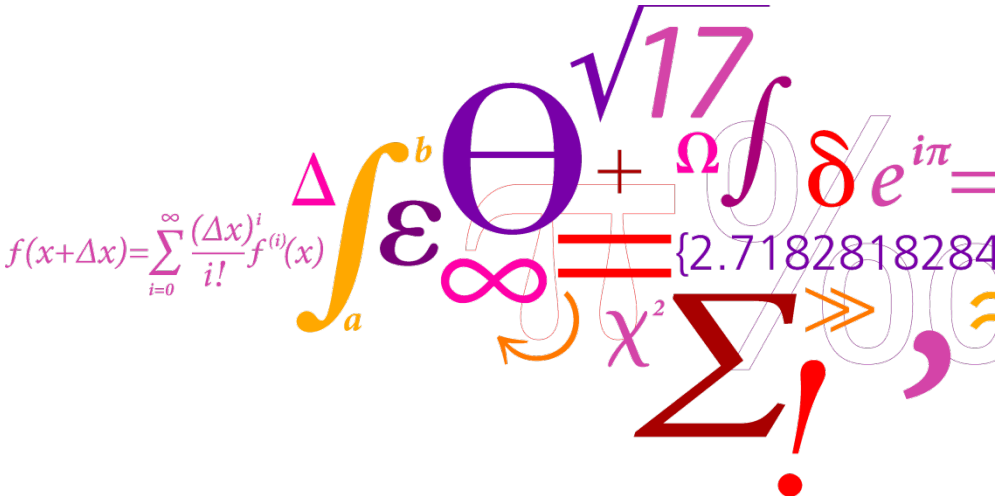

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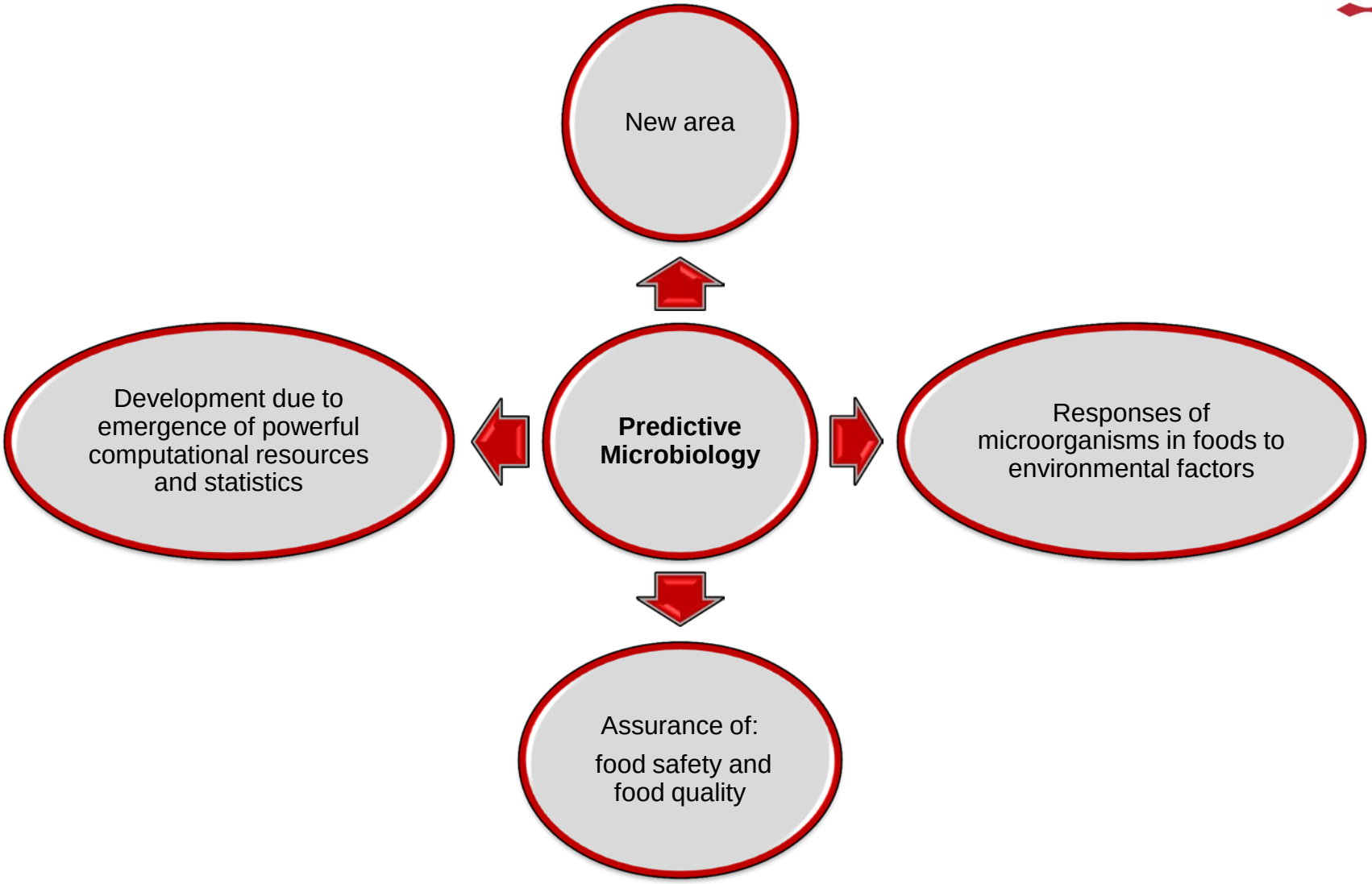
Outline:

- Definition
- Challenges
- Applications
- Example (Eg)
  - ✓ Introduction
  - ✓ Objectives of the study
  - ✓ Summarizing the performed work
  - ✓ Process to build up the developed models
  - ✓ Results
  - ✓ Remarks and future perspectives

Definition:



Source: Perez-Rodrigues and Valero, 2013.

Challenges:

- Many different researchers have developed models for the behaviour of particular microorganisms in laboratory media and different food matrices, and made them available in the public domain through peer reviewed publications (Ross and Dalgaard, 2004).
- From an industry perspective, the utility of these public-domain models is often somewhat limited:
  - ✓ In many cases, models have been developed under laboratory conditions,
  - ✓ are based on specific combinations of parameters that might not be appropriate for the particular food products of an industry,
  - ✓ and have not always been validated or even used in real food systems.
- Despite that, such models can be useful as long as their limitations are recognised and considered in their application (Membré and Lambert, 2008).

Applications:

Current applications of predictive microbiology in an industrial context are wide and according to Membré and Lambert (2008) can be summarised into three groups of activities:

1. **Product innovation**, where new products and process are developed, existing products are reformulated, storage conditions and shelf-life are determined, by assessment of speed of microbial proliferation, growth limits, or inactivation rate associated with particular food formulations and/or process conditions;
2. **Operational support**, where predictive models are used as support decision tools to implement or run a food manufacturing operation, such as designing in-factory heating regimes, setting Critical Control Points (CCPs) in Hazard Analysis and Critical Control Points (HACCP), assessing impact of process deviations on microbiological safety and quality of food products;
3. **Incident support**, where the impact on consumer safety or product quality are estimated in case of problems with products on the market.

Eg Transfer study

Modelling transfer of *Salmonella* Typhimurium DT104 during grinding of pork

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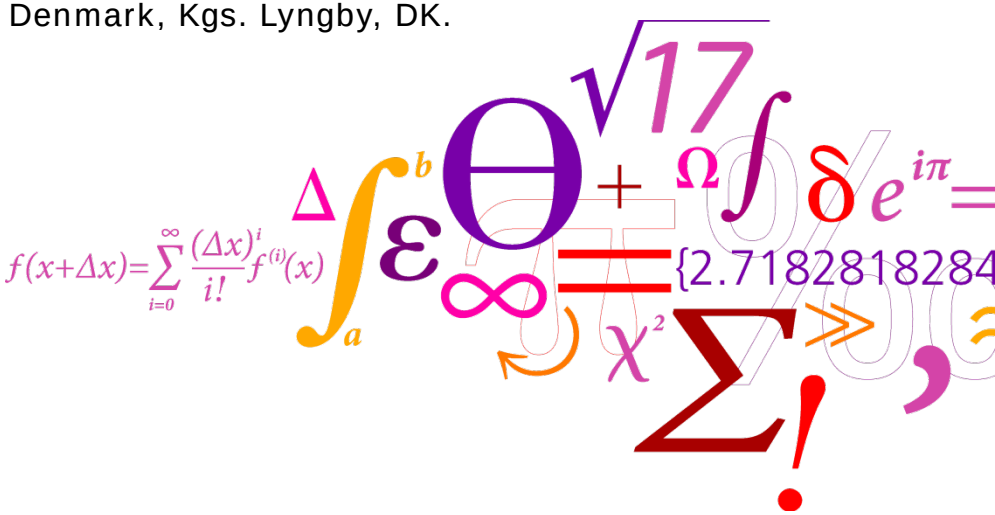

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Eg Transfer study

Introduction

- *Salmonella* is a critical pathogen (CDC, 2011; EFSA, 2010).
- Pork still is an important source of salmonellosis (EFSA, 2010; van Hoek *et al*., 2012; Wegener *et al*., 2003).
- Ground meat is frequently associated with outbreaks of salmonellosis (Stock and Stolle, 2001).
- Up to 70% of foodborne illnesses are estimated to be linked to catered food (Filion and Powell, 2011; Hensen et al., 2006; Jones et al., 2004; Lee and Middleton, 2003).
- In Denmark, 61 of 86 reported outbreaks in 2011 were associated with outside-the-home settings (anonymous, 2012).
- To model the distribution of pathogens during the processing operation are of major relevance to risk analysts (Flores, 2006).

Objective

The aim of this study was to develop a model able to predict cross contamination of *Salmonella* in pork grinding.

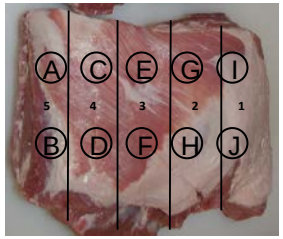
Eg Transfer study

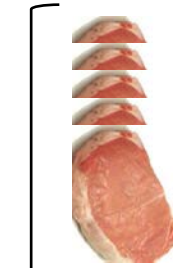
Experimental work

S. Typhimurium DT104

37° C ,overnight + 5° C, 1-3 days

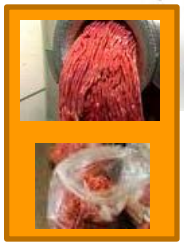
Ca.10^9 *Salmonella* / g





Matrix

Salmonella

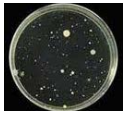


Up to100 slices

Distribution of Salmonella

37° C, 24h

22° C, 3d

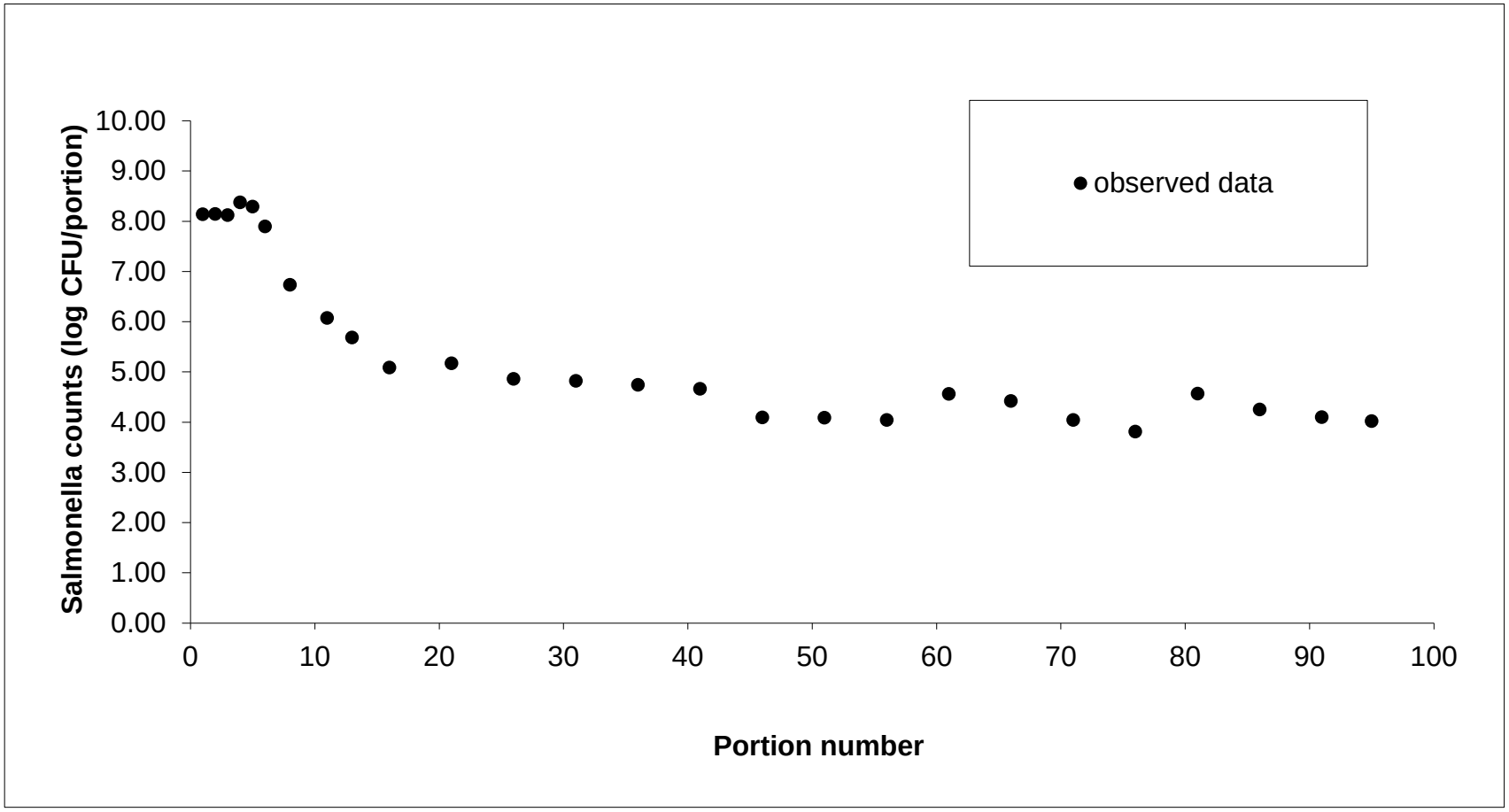


- Analysis performed
- Build up the model
- Validation

Transfer Modelling

Eg Transfer study

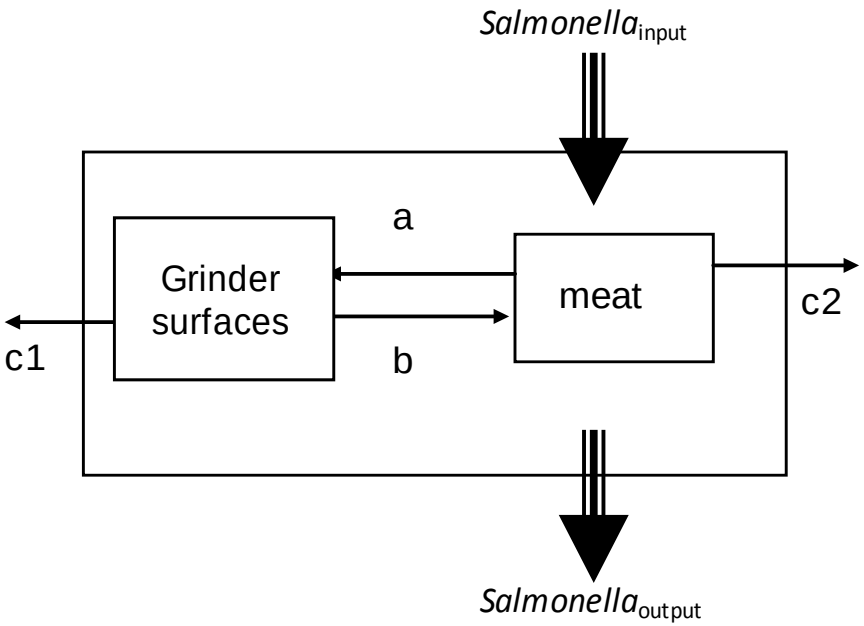
Describing the transfer rates of *Salmonella* during pork grinding



Eg Transfer study

Modelling cross-contamination during pork grinding

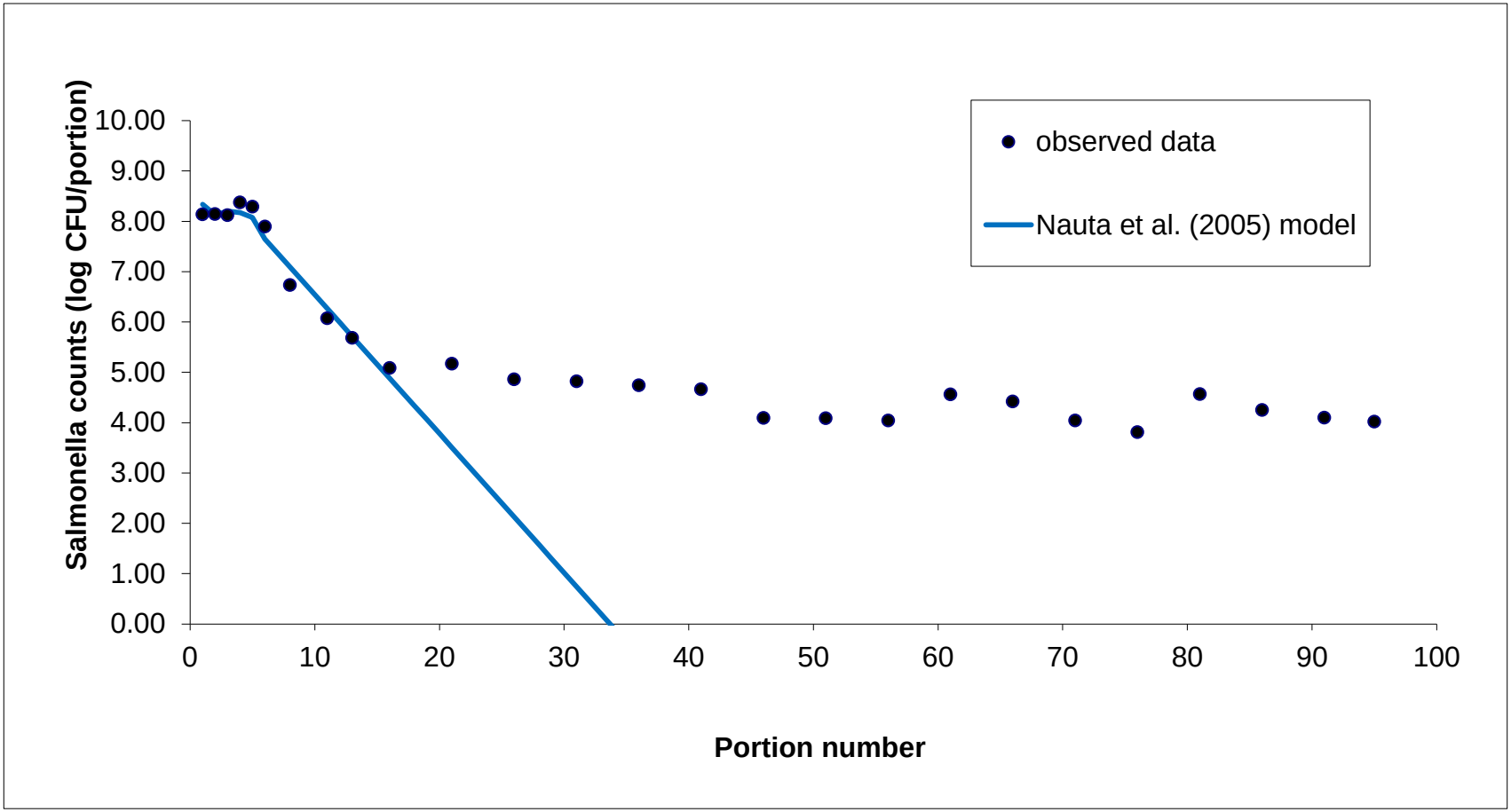
Nauta et al. (2005) Model



a: transfer of *Salmonella* from met to grinder
b: transfer of *Salmonella* from grinder to meat
c_1: *Salmonella* inactivated on grinder during the process
c_2: *Salmonella* inactivated on the ground meat

Eg Transfer study

Describing the transfer rates of *Salmonella* during pork grinding

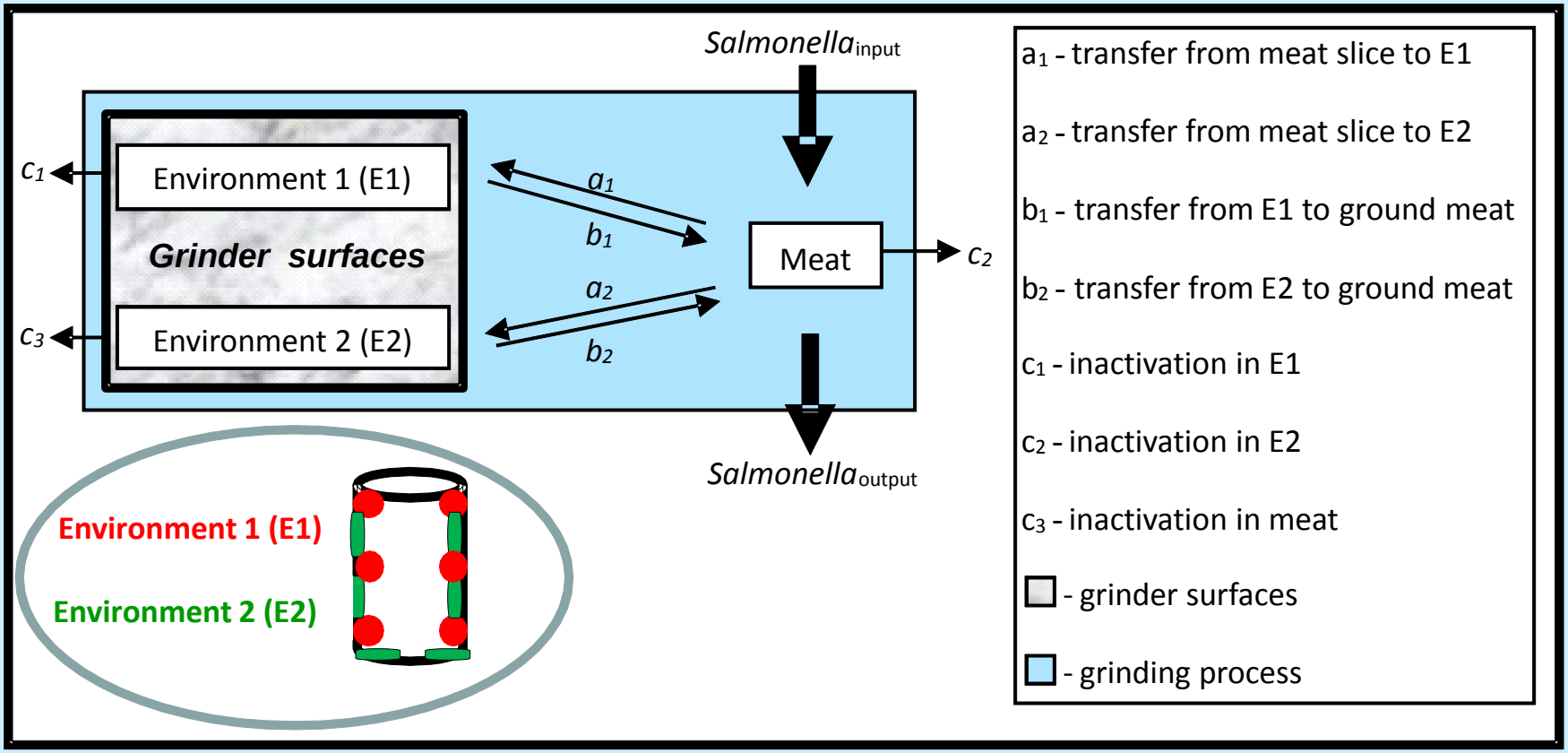


Transfer rates of *Salmonella* DT104 based on cell count data fitted to the suggested model

Eg Transfer study

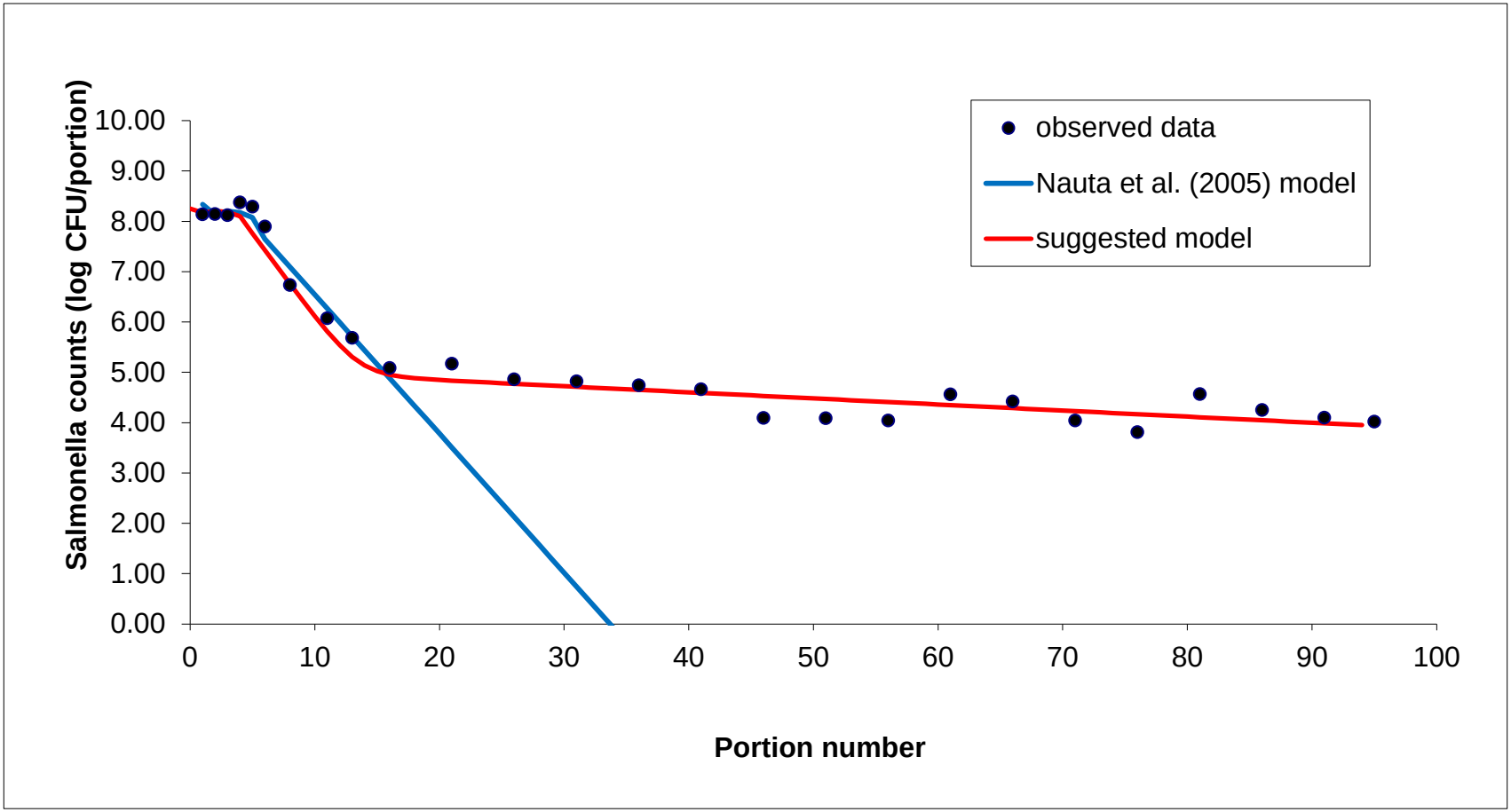
Modelling cross-contamination during pork grinding

Suggested Model



Eg Transfer study

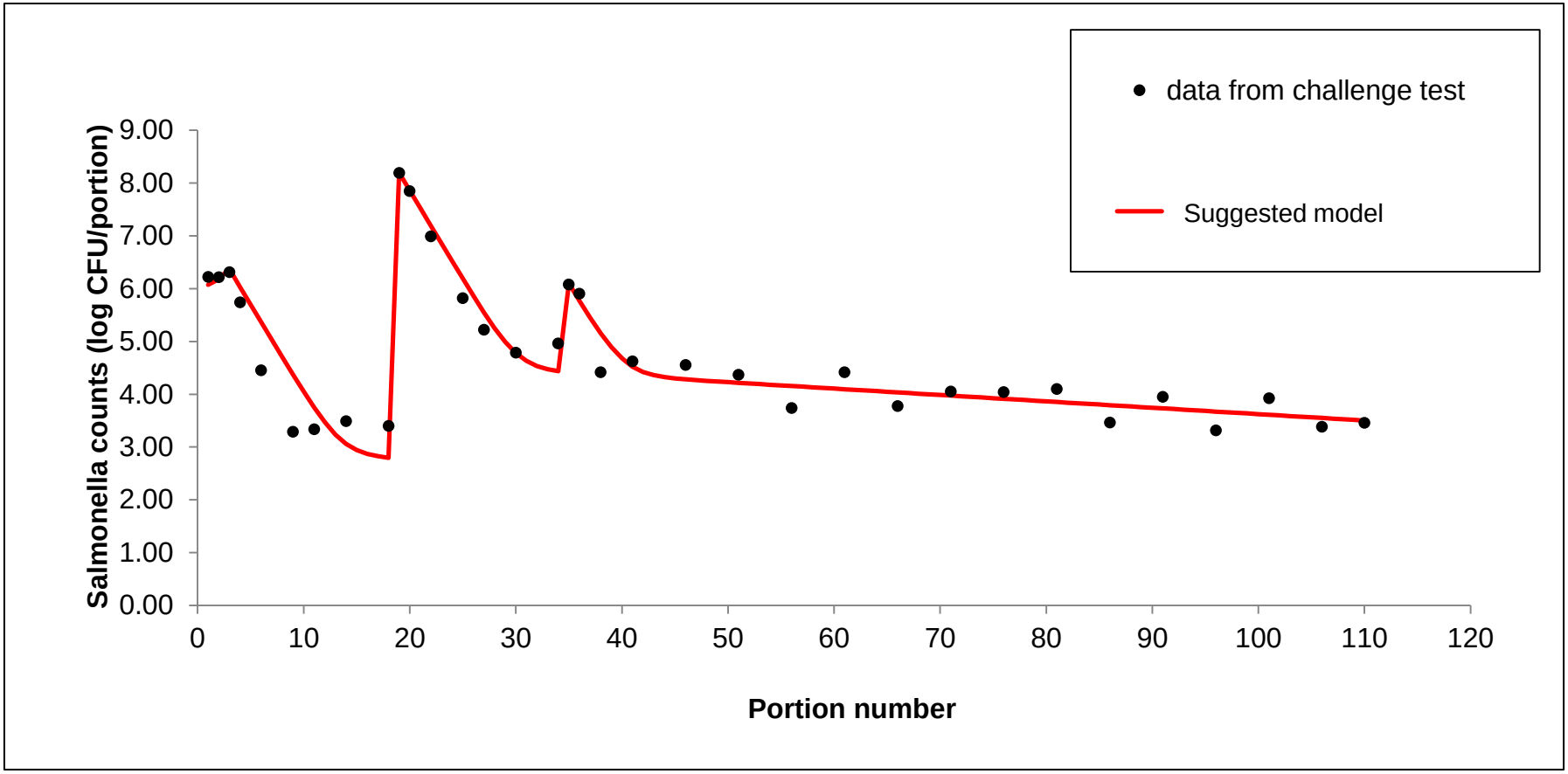
Describing the transfer rates of *Salmonella* during pork grinding



Transfer rates of *Salmonella* DT104 based on cell count data fitted to the suggested model

Eg Transfer study

Challenges in cross-contamination during pork grinding



Remarks and future perspectives

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ORIGINAL ARTICLE

Modelling transfer of *Salmonella* Typhimurium DT104 during simulation of grinding of pork

C.O.A. Møller[1], M.J. Nauta[1], B.B. Christensen[2], P. Dalgaard[3] and T.B. Hansen[1]

- Tail phenomenon
  - ✓Food processors
    - o Control measures
    - o Cleaning and sanitization
- Observed transfer successfully modelled
- Model can describe different processes
- Tool to support risk assessors

- **To be investigated:**
  - ✓ Food matrices
  - ✓ Pathogens
  - ✓ Inoculum levels
  - ✓ Processings

Available pathogen modeling programs

http://ucfoodsafety.ucdavis.edu/Food_Safety_Links/Pathogen_Modeling_Programs/#

Model name	URL	Applicability
1) American Meat Institute Process Lethality Determination Spreadsheet	http://ucfoodsafety.ucdavis.edu/files/40348.pdf	effectiveness of a specific heat process to destroy microorganisms of concern.
2) ComBase Predictor	http://www.combase.cc/index.php/en/predictive-models/134-combase-predictor	based on observations made in culture media, and comprise a set of 20 growth models, seven thermal death models and two non thermal survival models. Temperature, pH and a_w (usually as a function of NaCl) are the core factors

Available pathogen modeling programs

http://ucfoodsafety.ucdavis.edu/Food_Safety_Links/Pathogen_Modeling_Programs/#

Model name	URL	Applicability
3) DMRI - predictive models for meat	http://dmripredict.dk/Default.aspx?ReturnUrl=%2fModels%2fMeatSafety%2fDefault.aspx	Can be used to predict aspects of food safety and also food quality. All of the prediction tools from DMRI are based on data obtained from experiments with meat products.
4) Isothermal-Based Prediction Tool, IBPT	http://www.meathaccp.wisc.edu/pathogen_modeling/therm.html	can predict whether *Salmonella*, *E. coli* O157:H7, or *S. aureus* will grow to a “level of concern” in raw beef and pork products.

Available pathogen modeling programs

http://ucfoodsafety.ucdavis.edu/Food_Safety_Links/Pathogen_Modeling_Programs/#

Model name	URL	Applicability
5) OptiForm *Listeria* Control Model 2007	http://www.purac.com/EN/Food/Brands/OptiForm.aspx	help to calculate the level of lactate and diacetate needed to control *Listeria* in cured and uncured cooked meat and poultry products for their required shelf life.
6) Risk Management Tool for the Control of *Campylobacter* and *Salmonella* in Chicken Meat (Version 1.0)	http://www.mramodels.org/poultryRMTool/	To be used in conjunction with the Codex Guidelines for the Control of *Campylobacter* and *Salmonella* in chicken meat.

Available pathogen modeling programs

http://ucfoodsafety.ucdavis.edu/Food_Safety_Links/Pathogen_Modeling_Programs/#

Model name	URL	Applicability
7) Seafood Safety and Spoilage Predictor, SSSP v 3.0	http://sssp.dtuaqua.dk/	To predict the simultaneous growth of *Listeria monocytogenes* and lactic acid bacteria in lightly preserved seafood.
8) USDA Pathogen Modeling Program	http://ars.usda.gov/Services/docs.htm?docid=11550	Estimates the effects of multiple variables on the growth, inactivation or survival of foodborne pathogens. Most of the models are based on experimental data of microbial behavior in liquid microbiological media.

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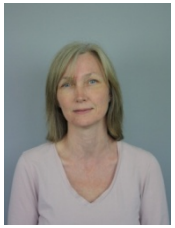

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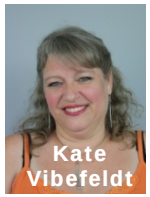

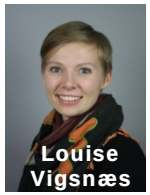

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